Problem Statement:

The goal of this project is to determine a simple method of finding the day of the week in which a person was born, given only a limited calendar view of the current month and simple operations of addition, subtraction, multiplication, and division. This set of instructions must be easily utilized by any individual, only requiring that they know the date of their birthday and the current date.

Process:

Initially, we began with the assumption that we could determine the needed day by finding the number of days since the individual was born, then adding that to an equation with the current day. By assigning a value to each day (Sunday = 0, Monday = 1, ...) we found that this equation would utilize modular arithmetic. For instance, the day 10 days before Sunday can be found through the equation:

$$x \equiv (0 - 10) mod\ 7$$

$$x \equiv (-10) mod\ 7$$

$$x = 4$$

By using this equation, the day should be Thursday. This can be confirmed by counting the days on a calendar. After more testing with other values, we were sure that our equation would be $Y = (X - N) mod\ 7$, where $Y =$ the day of the week in which the person was born, $X =$ the current day of the week, and $N =$ the number of days since the person was born.

However, we realized that N would become very difficult to calculate, as leap years exist and the constantly shifting value of the current day can get confusing. While continuing this path of logic is feasible, we decided to explore other options and found a more efficient method.

This new method, stemming from our original idea, was to calculate the day of the week of January 1st of the birth year, then find the day of birth by adding to January 1st. To find January 1st, we first created a formula to calculate the number of leap years between the year someone was born and 2025 (now). We must do this because our value of January 1st is relative to January 1st of 2025, finding the day through an almost identical strategy to our initial idea. To use this idea, however, the number of days from one date to another is needed. This value would be simple except for the fact that every fourth year has one additional day, so the number of days will equal $Number\ of\ Years \cdot 365 + \ of\ Leap\ Years\ Within\ Span\ of\ Time$.

After some experimentation we were able to come up with the following formula:

$$\left\lfloor \frac{2025 - Y - 1}{4} \right\rfloor + 1$$

Here, $Y =$ the person's year of birth, and $L =$ the number of leap years from the year of birth to 2025. In this equation, $2025 - Y - 1$ is the number of years between 2025 and the birth year. We divide by 4 because there is a leap year every 4 years. We add 1 because there is always at least one leap year in the time span from any year before 2025 (2024 is a leap year).

We notice that 365 mod 7 is = 1, thus, if Jan 1st was a Monday for example, the next year would be offset by only one day, meaning Jan 1st would then be a Tuesday. If it's a leap year, then you are offset by 2 days.

We calculated the day of the week that Jan 1st, 2025, was, and we got 3, or Wednesday.

This led us to our initial equation for finding the day of the week for Jan 1st any given year:

$$D = 3 - 2025 + Y - L \bmod 7$$

Here, Y stands for the year that the person is born, and L is the amount of leap years.

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(2025-Y) is the number of years that have elapsed, so it is subtracted from 3 (initial day of the week value) to get the day of the week of Jan 1st any given year assuming no leap year.

The # leap years is also adjusted for and considered.

We then made a table for any month that you were born in.

If you were born in February, it's a given that we need to add every day in January. If you're born in March, we must add every day in January and February.

We took the number of days in the sum of the months up until the birth month and put it mod 7 to get the offset for day of the week.

For example, if you were born in May, you only add 1 to your day of the week, since the number of days from Jan-Apr mod 7 are equal to 1.

We now have a number that is ≡ the day of the of the week of the first day of the birth month (Ex. Feb 1st or Aug 1st)

We then add the birthday date (Aug **18**th) to this value and subtract 1 (it's non inclusive).

We also account for leap years with an if statement (If date is after Feb 28th AND it's a leap year, add 1 to value).

Take this final value and make it mod 7, and you have your day of the week!

We provided a table that the person can use showing them which day of the week their number would represent (0 for Sunday, 1 for Monday etc.)

Solution:

We define 2 variables as the following:

$Y =$ Your Birth Year

$D =$ Day of the Month

We will define the following variables later:

- L
- T
- M_1
- S_1
- W_1

- F
- P
- A
- M_2
- W_2
- S_2

First let's find the number of leap years:

Plug your Y into this equation:

$$L = \frac{2024 - Y}{4} + 1$$

Round L down.

Let's find the day of the week of Jan 1st for your birth year:

Plug your Y into this equation:

$$T = -2022 + Y - L$$

Now, we are going to get this number Mod 7:

Plug your T into this equation:

$$M_1 = \frac{T}{7}$$

Round M down.

$$S_1 = T - 7M_1$$

Then,

$$W_1 = 7 + S$$

This represents the day of the week of January 1st during your birth year.

Use this table:

Jan	Add	0
Feb	Add	3
Mar	Add	3
Apr.	Add	6
May	Add	1
Jun	Add	4
Jul	Add	6
Aug	Add	2
Sep	Add	5
Oct	Add	0
Nov	Add	3
Dec	Add	5

$F = S +$ the number assigned to your birth month

We now have the day of the week for the first day of your birth month!

Now add your birthday date and subtract 1:

$$P = F + D - 1$$

This is the day of the week that your birthday is on, assuming no leap year.

Take leap year into account now:

If your birthday is after February 28th

AND

your birthday is on a leap year (year is divisible by 4):

Then,

$$A = P + 1$$

If either of those conditions are false:

Then,

$$A = P$$

Now, we are going to get this number Mod 7:

Plug your A into this equation:

$$M_2 = \frac{A}{7}$$

Round M down.

$$S_2 = A - 7M$$

Use your S_2 in the table below to find the day of the week that you were born:

After this process, the variable A will contain the number of the day of the week in which you were born, in which:

Day of the Week	Number Assigned (A)
Sunday	**0**
Monday	**1**
Tuesday	**2**
Wednesday	**3**
Thursday	**4**

Friday	**5**
Saturday	**6**

Extensions:

1. Try to find the day of a person's birthday in any year, past or future.
    a. Use the same method as explained above, except with the wanted birthday year instead of the true birth year. This will output the day of the birthday in that year.

2. Given a day of the week and a day of the month, can you calculate the ten most recent dates that can house a birthday fulfilling those requirements?
    a. Adapt the method above to work in reverse, plugging in the day of the week and day of the month to find potential birthdays. This strategy would require some guesswork, however, so a better strategy could be formulated.
3. Make a single equation that, when fed the necessary information, spits out the value associated with the day of the week.
    a. This would require some more advanced functions, such as mod 7, to solve. Other than this, all else would be to condense the strategy above until it is contained in one function.
4. Extend this method to give a celebrity who had been born on the same day.
    a. Instead of ending the method at correlating a number to a day, replace the table above with this:

Number:	Celebrity:				
0	Zendaya	Katharine Hepburn	Whoopi Goldberg	Kate Winslet	Louis Armstrong
1	Zoe Saldana	Jodie Foster	Bill Clinton	Shirley Temple	Henry "Hank" Aaron
2	Billie Eilish	Michelle Pfeiffer	Marilyn Monroe	Harry Styles	Dr. Martin Luther King Jr.
3	Taylor Swift	Dr. Seuss	Roald Dahl	Cullen Jones	Maya Angelou
4	Olivia Rodrigo	Stephen Spielberg	Nelson Mandela	Matt Damon	Shel Silverstein
5	Oprah Winfrey	Michelle Obama	Jesse Owens	Madeleine L'Engle	John Mulaney
6	Taye Diggs	Pink	Sylvester Stallone	Bob Dylan	